6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Spline-Based Methods for Solving Thermal and Mechanical Fluid-Structure Interaction in Compressible Flows

M. Make[1,2], N. Hosters[1] and M. Behr[1]

[1] Chair for Computational Analysis of Technical Systems,
RWTH-Aachen University, Schinkelstrasse 2 52062, Aachen Germany.
[2] make@cats.rwth-aachen.de

Keywords: *Compressible Flow, NURBS-Enhanced Finite Elements, Thermal-Mechanical Fluid-Structure Interaction.*

In many engineering applications involving trans- or supersonic flows, considering thermal-mechanical fluid-structure interaction (FSI) phenomena is of great importance. In the design process of space-propulsion systems, for example, neglecting such phenomena could lead to poor design decisions and possible system failure [1]. Additionally, in order to predict the effects of shock-wall interactions, an accurate geometric representation of the design is key.

In the current work, we present a spline-based coupled approach capable of simulating compressible flow problems involving thermal and mechanical FSI phenomena. Both the fluid and structural solver, make use of a common spline definition to represent the geometry. By doing so an exact geometric description of the coupling interface is obtained and additional errors caused by non-matching grids are omitted.

On the fluid domain, the compressible Navier-Stokes equations are solved using our in-house finite element solver XNS. This solver is based on the Deforming Spatial Domain/Stabilized Space-Time (DSD/SST) procedure extended by NURBS-enhanced finite elements [2]. On the structural domain, the thermo-elastic problem is solved using FEAFA, our in-house structural finite elements solver extended with isogeometric analysis [2]. Both solvers are coupled using a staggered approach through the Aero-Thermoelastic Coupling Module (ATCM). The complete framework is demonstrated by means of a set of two-dimensional test cases.

REFERENCES

[1] Hosters, N., Klaus, M., Schieffer, G., Behr, M. and Reimerdes, H.-G. Towards aerothermoelastic simulations of supersonic flow through nozzles. In: *Proceedings of the 4th European Conference for Aero-Space Sciences*, Saint Petersburg, Russia, July 4-8, 2011.

[2] N. Hosters, J. Helmig, A. Stavrev, M. Behr, S. Elgeti, Fluid-structure interaction with NURBS-based coupling, *Comput. Methods Appl. Mech. Engrg.* (2018), https://doi.org/10.1016/j.cma.2018.01.003